

# Primary-Side Power Control IC for LED Lights

## Monolithic IC MM3460XF

### Outline

This IC is a PFC switching power control IC for LED lights.

It uses a one-converter system into which a PFC (Power Factor Correction) circuit and an AC-DC converter become integrated. Compared to a regular two-converter, a high-efficient configuration can be achieved due to reduction in the number of parts and little power loss. In addition, there is me as the protection setting that built-in specialized input low voltage, overvoltage protection, output overvoltage with a delay, a short protection circuit in for one-converter / for LED lights as a protection circuit and I compare it with conventional PFC-IC and can set it with few part marks.

Moreover, the consumption of start-up current and current during operation are lowered for low standby mode electricity.

This IC uses SOP-8 package and supports flow conditions.

### Features

Limits for harmonic current emissions (one-converter system)

PF≒0.99 (reference value)

High efficiency: 88% (reference value, at rated load)

Reduction in the number of parts by not using an active filter (PFC) control circuit

Longer life can be achieved by not using the primary electrolytic capacitor

1. High voltage input : 28V
2. LED output : 5~60W
3. Critical conduction current mode
4. Built-in input UVLO, overvoltage protection (28V Zener) circuits
5. Built-in output (FB) short, overvoltage protection circuits (with a delay feature)
  - \* This Function is original protection
6. Start-up current (30μA), current during operation (1mA)

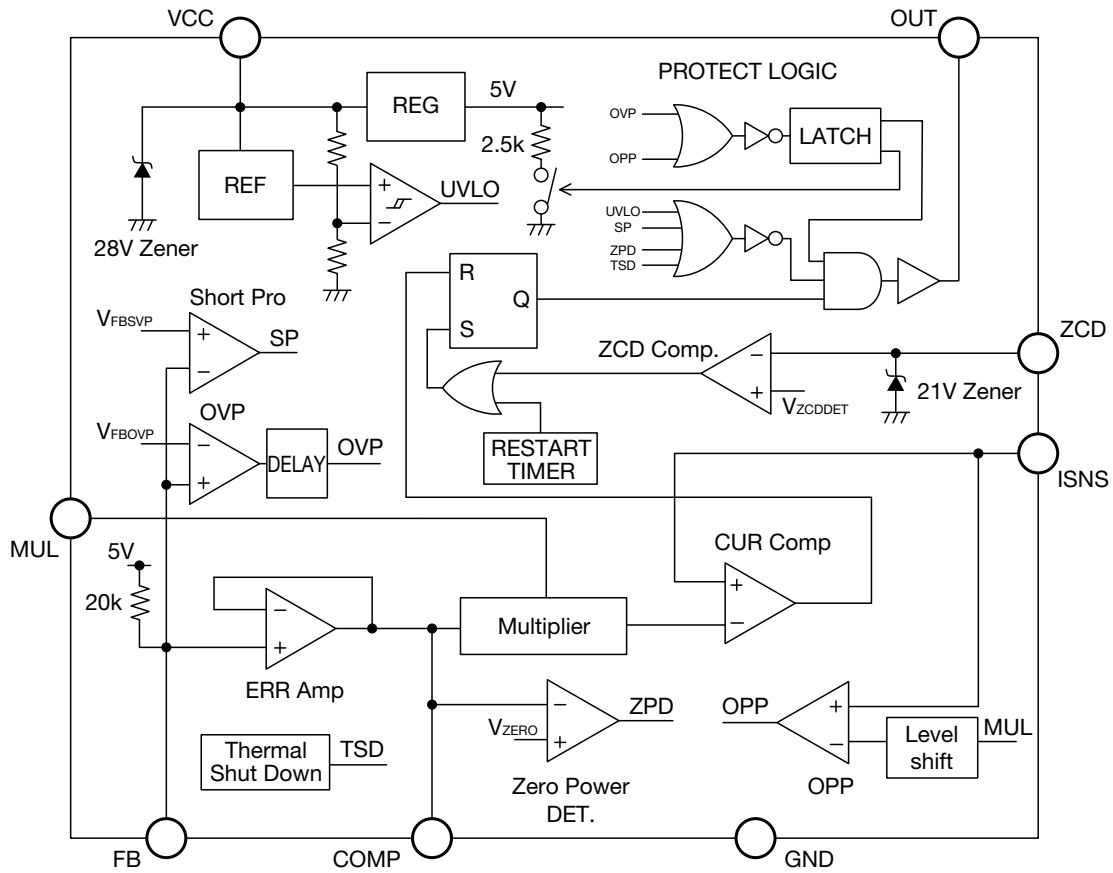
### Package

SOP-8D

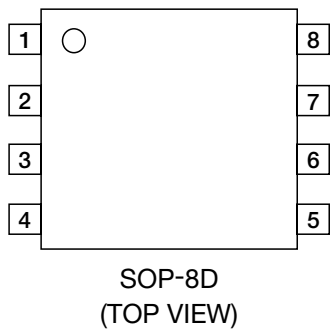
### Applications

1. LED lighting devices
2. LED bulbs
3. Other power supplies

Block Diagram



Pin Assignment



1	FB
2	COMP
3	MUL
4	ISNS
5	ZCD
6	GND
7	OUT
8	VCC

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Pin Description

Pin No.	Pin Name	INPUT/OUTPUT	Function	Internal Equivalent Circuit
1	FB	INPUT	Input of the error amplifier.	
2	COMP	OUTPUT	Output of the error amplifier.	
3	MUL	INPUT	Input to the multiplier.	
4	ISNS	INPUT	Input to the current comparator for sensing MOSFET current signal.	
5	ZCD	INPUT	Input for the transformer zero detect comparator.	
6	GND		GND	
7	OUT	OUTPUT	Gate driver Output for driving MOSFET.	
8	VCC	INPUT	Power supply.	

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**Absolute Maximum Ratings** (Except where noted otherwise Ta=25°C)

Item	Symbol	Ratings	Units
Storage temperature	T <sub>STG</sub>	-55~+150	°C
VCC Supply voltage	V <sub>CCMAX</sub>	-0.3~Self limit (28)	V
VCC pin input current	I <sub>VCCMAX</sub>	+10	mA
FB pin supply voltage	V <sub>FBMAX</sub>	-0.3~+6	V
MUL pin supply voltage	V <sub>MULMAX</sub>	-0.3~+6	V
ISNS pin supply voltage	V <sub>ISNSMAX</sub>	-0.3~+6	V
ZCD pin input current	I <sub>ZCDMAX</sub>	-2~+5	mA
OUT pin input current	I <sub>OUTMAX</sub>	-600~+700	mA
Power dissipation	P <sub>d</sub>	300 (alone)	mW

\* Absolute Maximum Ratings are those values beyond which the life of the device may be impaired.

**Recommended Operating Conditions**

Item	Symbol	Ratings	Units
Operating temperature	T <sub>OPR</sub>	-40~+105	°C
Operating supply voltage	V <sub>OPR</sub>	10~25.5	V
MUL pin supply voltage	V <sub>INMUL</sub>	0~+5.5	V
FB pin supply voltage	V <sub>INFB</sub>	0~+5.5	V
ISNS pin supply voltage	V <sub>INISNS</sub>	0~+5.5	V

**Electrical Characteristics** (Except where noted otherwise Ta=25°C, VCC=15V)

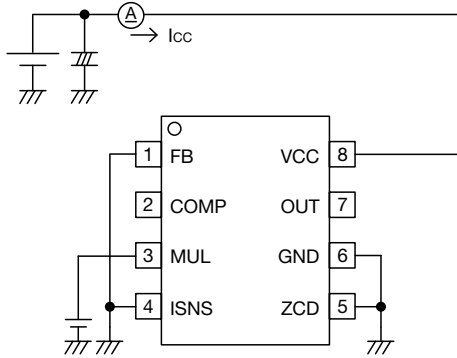
Item	Symbol	Measurement conditions	Circuit	Min.	Typ.	Max.	Units
Start-up power supply current	I <sub>DDOFF</sub>	VCC=9V	①		30	50	μA
Power supply current	I <sub>DDON</sub>		①		1	2	mA
<b>UVLO</b>							
Under voltage lockout (UVLO)	V <sub>UVLO</sub>	VCC=H→L	①	8	9	10	V
Under voltage lockout release voltage	V <sub>UVLORelease</sub>	VCC=L→H	①	11.5	13.0	14.5	V
Under voltage lockout hysteresis voltage	V <sub>UVLOhys</sub>	VCC=H→L→H	①	3.3	4.0	4.7	V
VCC clamp voltage	V <sub>VCCclamp</sub>	I <sub>VCC</sub> =1mA	②	25.5	28	30	V
<b>ERR Amplifier</b>							
Pullup resistance	R <sub>PULLUP</sub>		④	14	20	26	kΩ
FB pin bias current	I <sub>FB</sub>	FB=1V	④	-100	-200	-300	μA
COMP pin source current	I <sub>COMPSource</sub>	COMP=0V	④	-35	-70		μA
COMP pin sink current	I <sub>COMPSink</sub>	COMP=5V	④	2.0	3.5		mA
<b>Multiplier</b>							
Amplification ratio K	K	MUL=1V, FB=COMP=2.25V	⑤	0.53	0.75	0.97	V
Multiplier input voltage	V <sub>MUL</sub>		⑤	0~2.5	0~3.5		V
	V <sub>COMP</sub>		⑤	1.25~2.5	1.25~3.5		V
Multiplier clamp voltage	V <sub>MULclamp</sub>	MUL=3.5V, FB=COMP=2.75V	⑤	2.2	2.6		V
<b>Zero current detect</b>							
ZCD detection voltage	V <sub>ZCDDet</sub>	ZCD=3V→0V	⑥	1.3	1.5	1.8	V
ZCD Input high clamp voltage	V <sub>ZCDclampH</sub>	I <sub>ZCD</sub> =1mA	②	19.5	21	22.5	V
ZCD Input low clamp voltage	V <sub>ZCDclampL</sub>	I <sub>ZCD</sub> =-1mA	②	-0.9	-0.6	-0.4	V
<b>Cyrrrent sense comparator</b>							
Delay time	I <sub>ISNS</sub>	FB=1.5V ISNS=0V→3V	⑤		200	400	ns
<b>Drive</b>							
On resistance (sink)	R <sub>ONsink</sub>		③		8	12	Ω
On resistance (source)	R <sub>ONsource</sub>		③		10	15	Ω
Output rise time	T <sub>rise</sub>	C <sub>out</sub> =1000pF Guaranteed by design	③		60	120	ns
Output fall time	T <sub>fall</sub>	C <sub>out</sub> =1000pF Guaranteed by design	③		30	70	ns
<b>Restart timer</b>							
Deley time	T <sub>RESTART</sub>		⑥	100	200	400	μs
<b>Zero Power Detection</b>							
Zero power detection voltage	V <sub>ZERO</sub>	COMP=2V→0V	⑥	0.7	1.0	1.3	V

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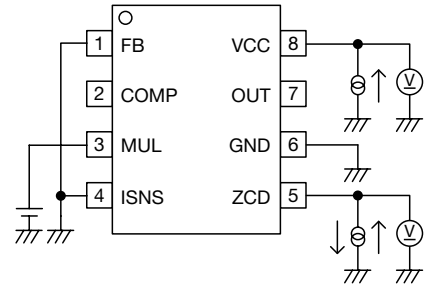
Item	Symbol	Measurement conditions	Circuit	Min.	Typ.	Max.	Units
<b>FB OVP Detection</b>							
FB OVP detection voltage	$V_{FBOVP}$	FB=1V→5V	⑥	3.0	3.5	4.0	V
FB OVP detection deley time	$T_{FBOVP}$		⑥	50	100	200	ms
<b>FB short Detection</b>							
FB Short detection voltage	$V_{FBSVP}$	FB=1V→0V	⑥	0.3	0.5	0.7	V
FB Short detection hysteresis voltage	$V_{FBSVphys}$	FB=1V→0V→1V	⑥	0,1	0.2	0.3	V
<b>Over Power Detection</b>							
Over Power detection voltage	$V_{ISOPP}$	MUL=0V, ISNS=0V→5V	⑤	4.0	4.5	5.0	V
<b>Thermal Shut Down</b>							
TSD detection temp.	$T_{DET}$	Guaranteed by design			150		°C
TSD release temp.	$T_{RELEASE}$	Guaranteed by design			130		°C

Measuring Circuit

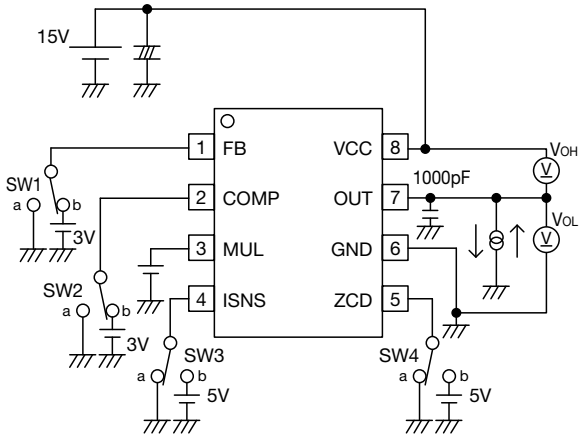
①  $I_{DDOFF}$ ,  $I_{DDON}$ ,  $V_{UVLO}$ ,  $V_{UVLORelease}$ ,  $V_{UVLOhys}$



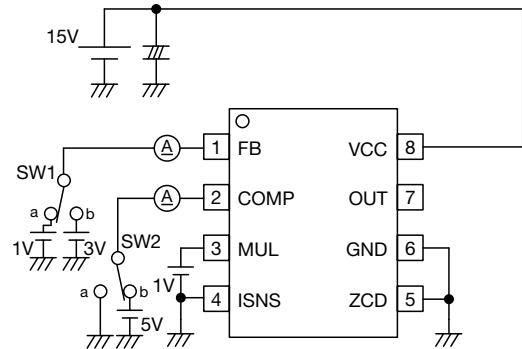
②  $V_{VCCclamp}$ ,  $V_{ZCDclampH}$ ,  $V_{ZCDclampL}$



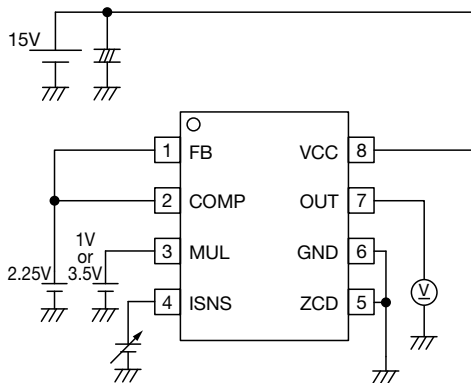
③  $R_{ONsink}$ ,  $R_{ONsource}$ ,  $T_{rise}$ ,  $T_{fall}$



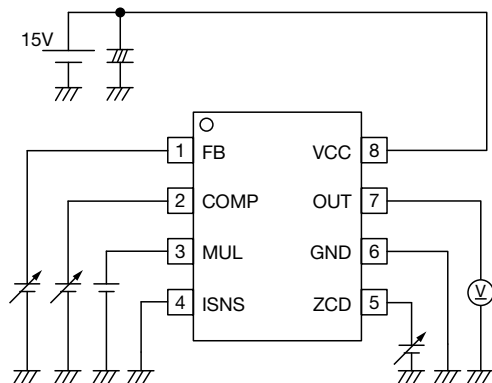
④  $R_{PULLUP}$ ,  $I_{FB}$ ,  $I_{COMPsource}$ ,  $I_{COMPSink}$



⑤  $K$ ,  $V_{MUL}$ ,  $V_{COMP}$ ,  $V_{MULclamp}$ ,  $V_{ISOPP}$ ,  $T_{ISNS}$

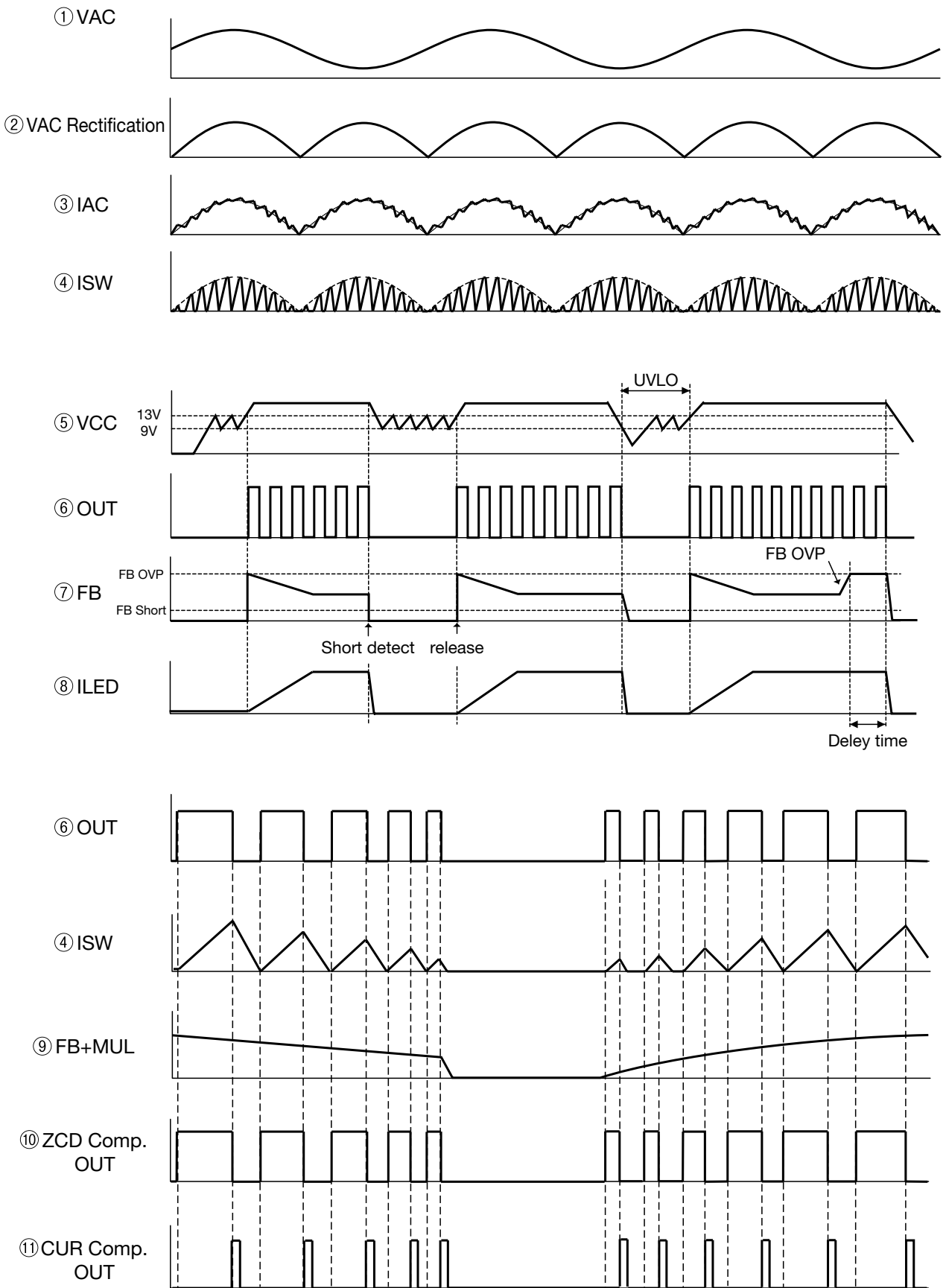


⑥  $V_{ZCDEDET}$ ,  $T_{RESTART}$ ,  $V_{ZERO}$ ,  $V_{FBSVP}$ ,  $V_{FBSVPhys}$ ,  $V_{FBOVP}$ ,  $T_{FBOVPhys}$



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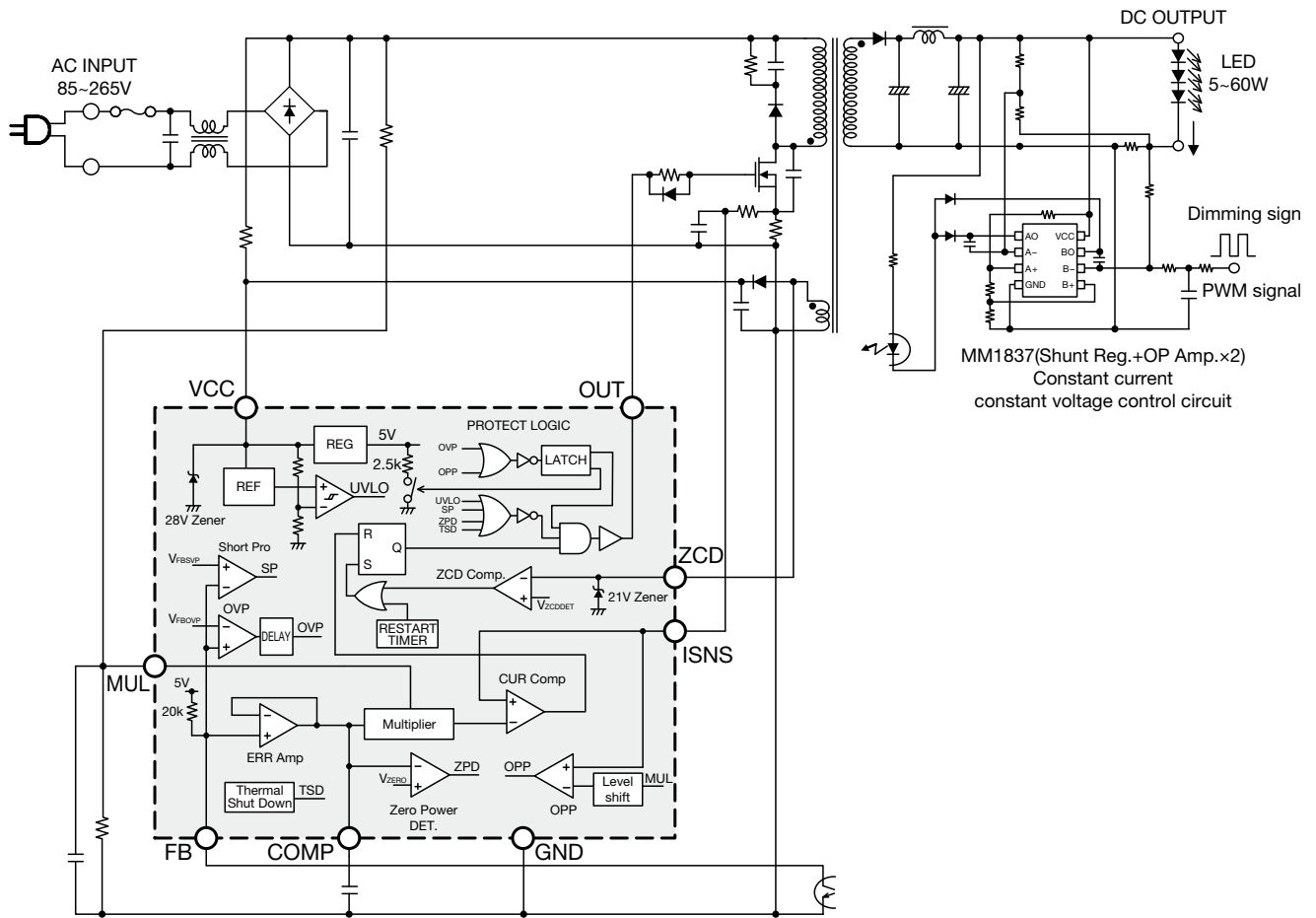
Timing Chart



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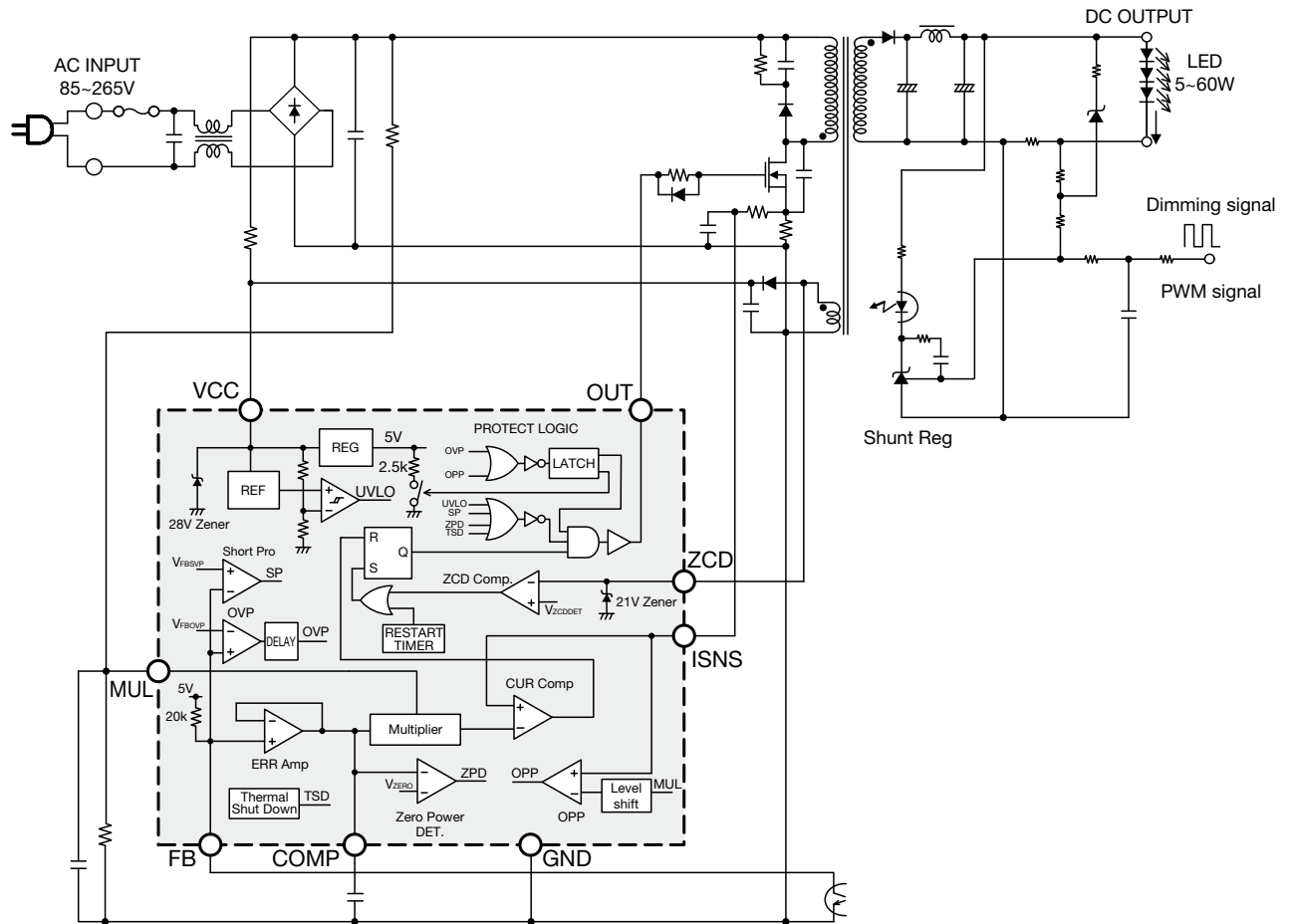
Application Circuit



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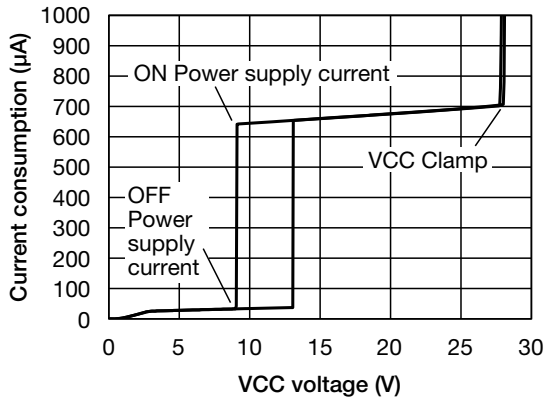




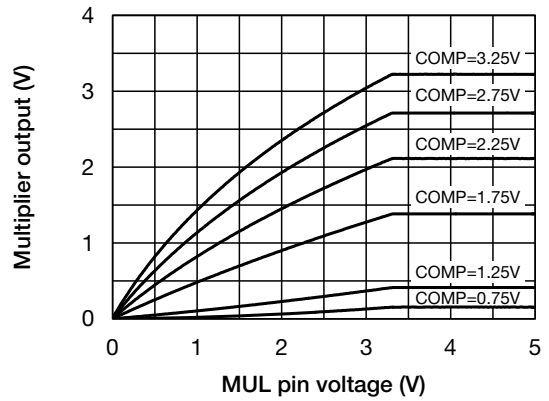
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Characteristics

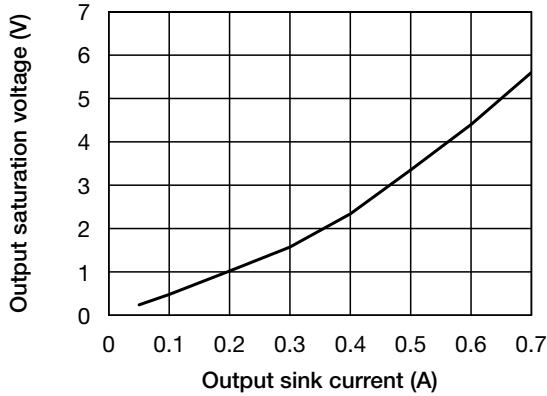
**VCC voltage - Current consumption**  
 (VCC=0→30V→0V, FB=1.0V, MUL=1.0V, ZCD=0.0V, ISNS=0V)



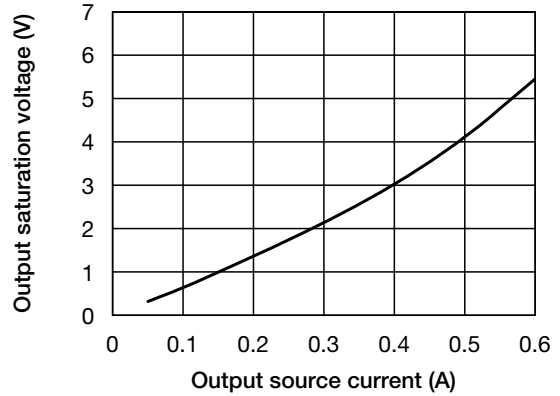
**MUL pin voltage - Multiplier output**  
 (MUL=0→5V, COMP=0.75→3.25V, FB=1.0V, ZCD=0.0V, ISNS=0.0V)



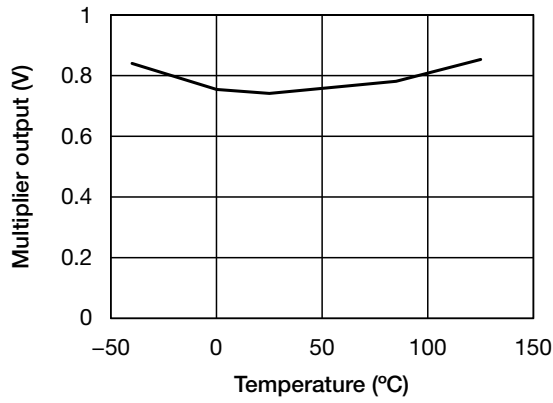
**OUT pin voltage - OUT pin sink current**  
 (VCC=15V)



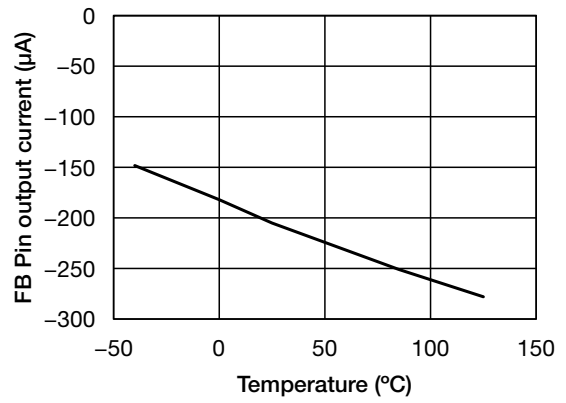
**OUT pin voltage - OUT pin source current**  
 (VCC=15V)



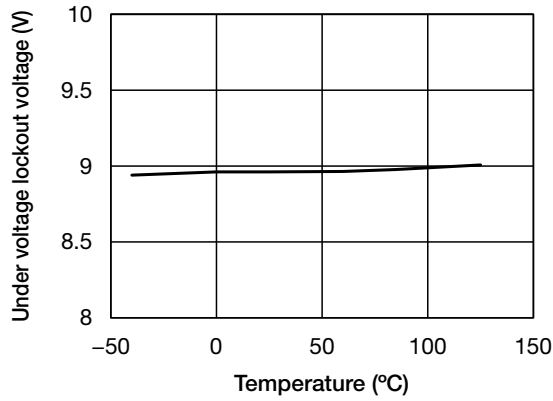
■ Multiplier output - Temperature  
(FB=2.25V, MUL=1.0V, ZCD=0.0V, ISNS=0.0V)



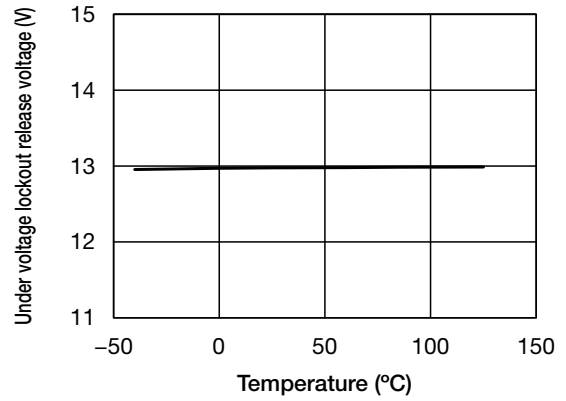
■ FB pin output current - Temperature  
(FB=1.0V)



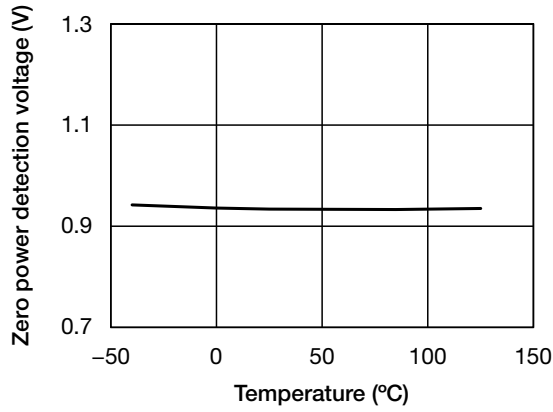
■ Under voltage lockout voltage - Temperature  
(VCC=15→0V)



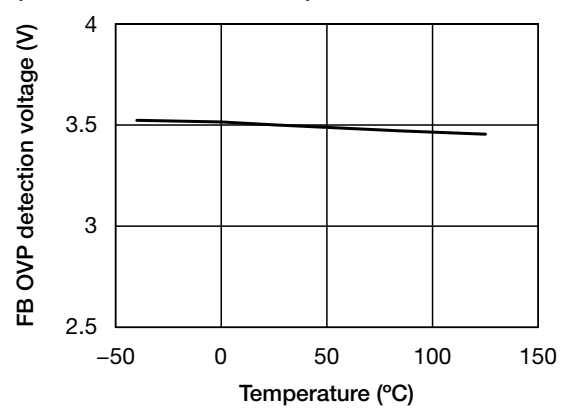
■ Under voltage lockout release voltage - Temperature  
(VCC=0→15V)



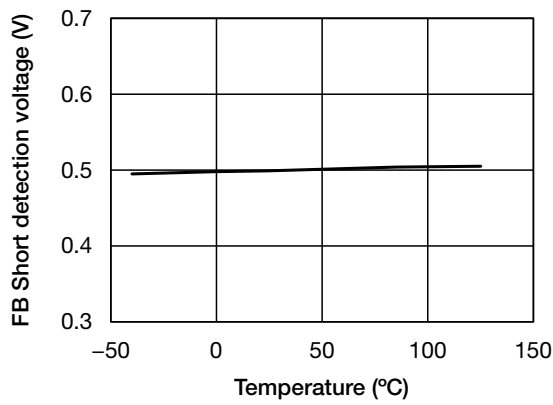
■ Zero power detection voltage - Temperature  
(VCC=15V, COMP=2V→0V)



■ FB OVP detection voltage - Temperature  
(VCC=15V, FB=2V→5V)

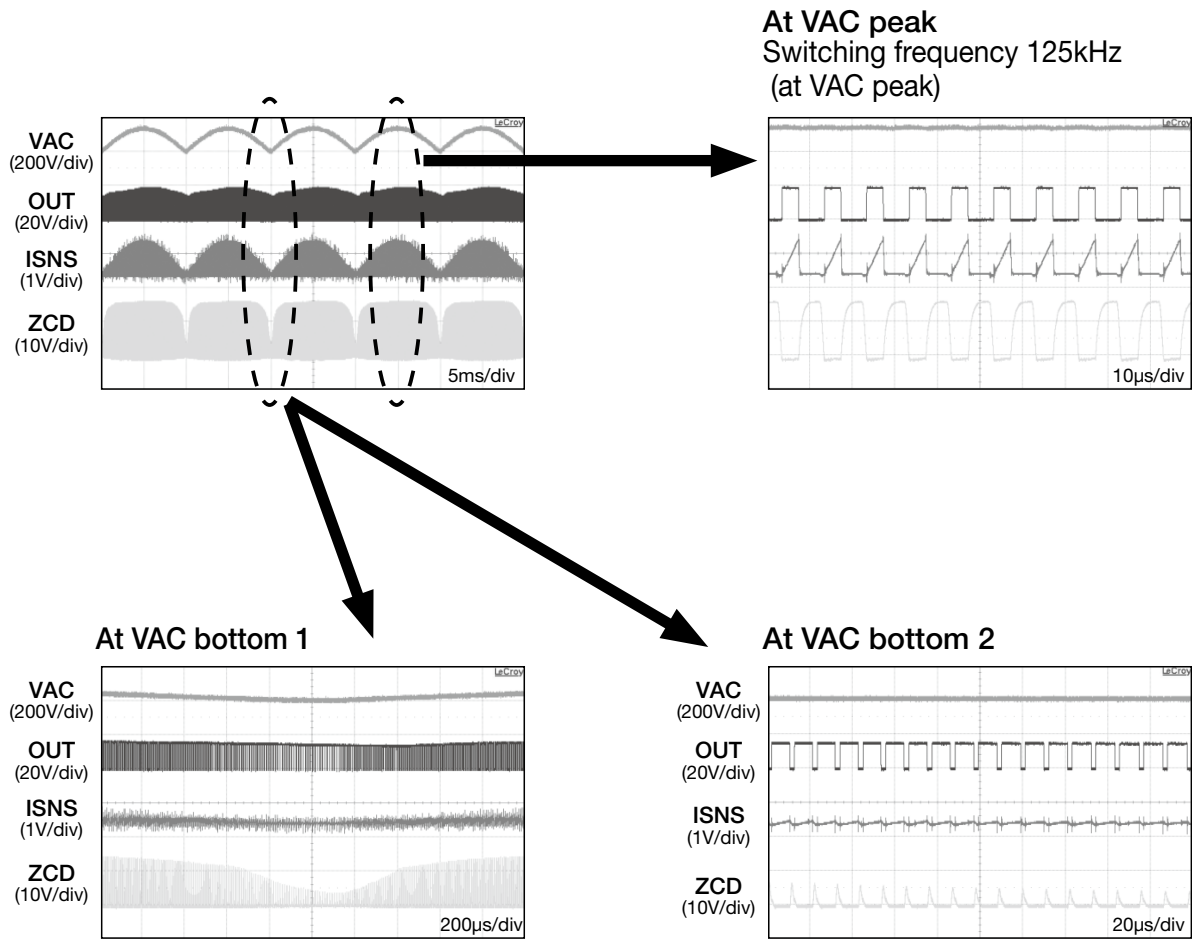


■ FB Short detection voltage - Temperature  
(VCC=15V, FB=2V→0V)



Basic Operation Waveforms

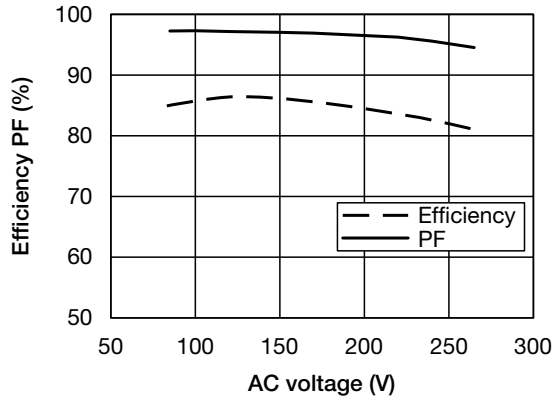
Input; AC=100V/50Hz, Output; 8LEDs/350mA→Efficiency; 87%, Power factor; 99%



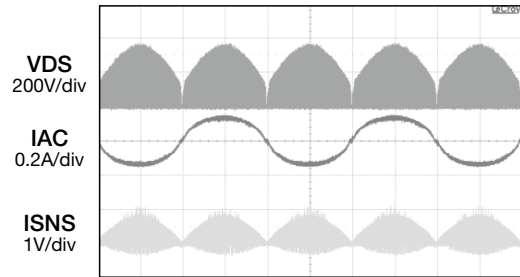
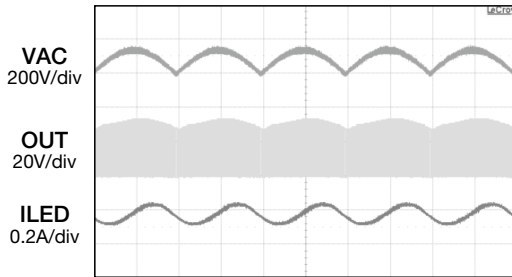


**Line regulation**  
 AC 85~265V (World wide input demo board) 8LEDs/350mA

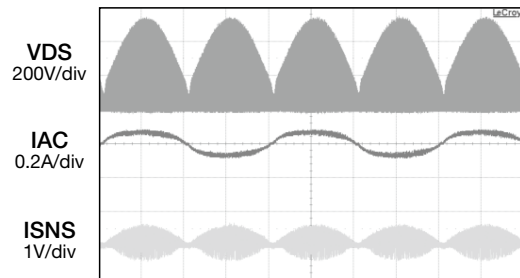
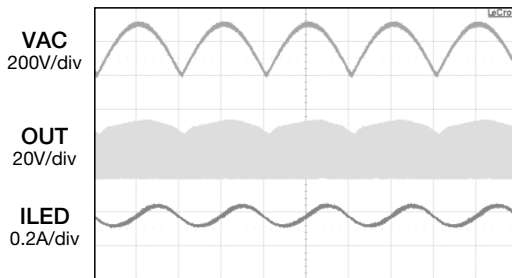
(AC Voltage vs Efficiency , Power factor)



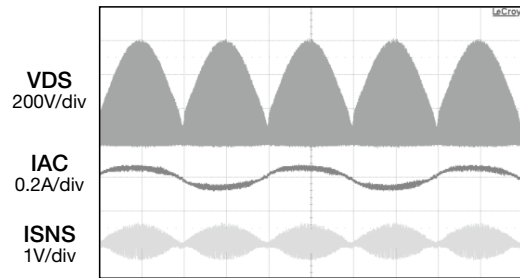
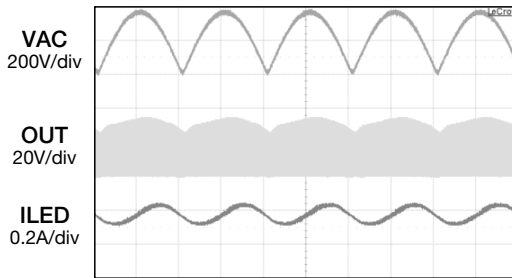
IN : AC 100V



IN : AC 220V



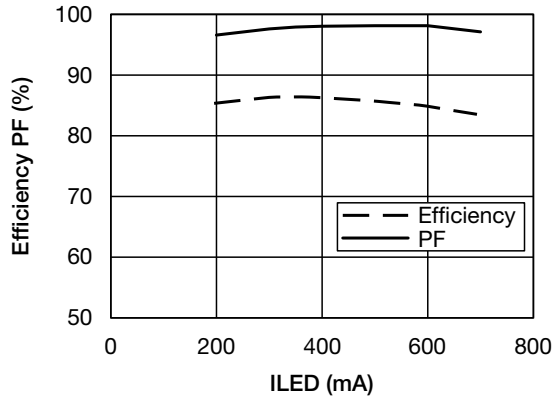
IN : AC 265V



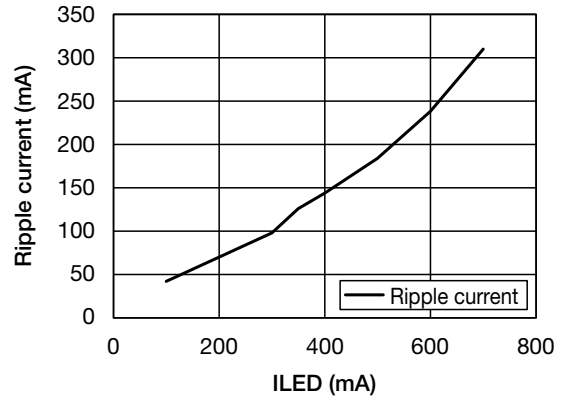
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**Line regulation**  
 AC 85~265V (World Wide Input Demo Board) 8LEDs/50mA

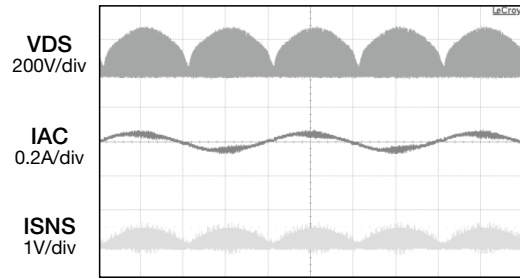
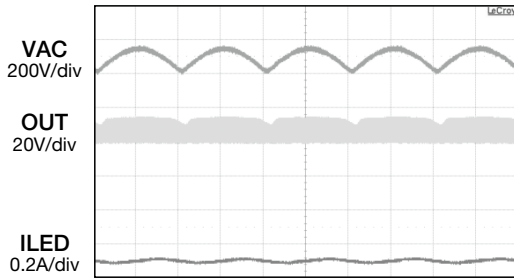
(ILED vs Efficiency, Power factor)



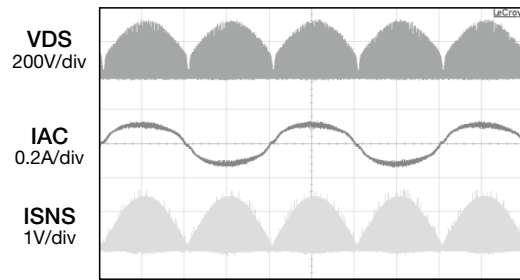
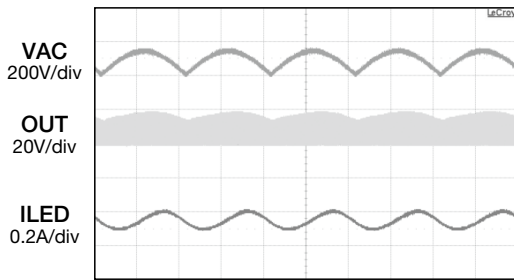
(ILED vs Output ripple current)



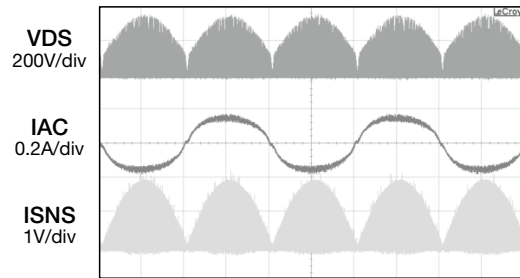
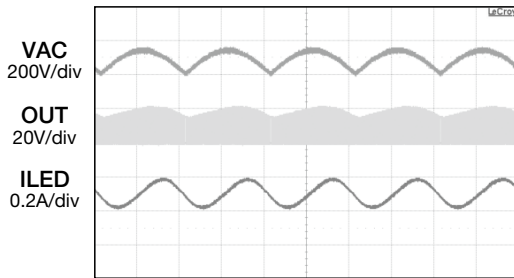
**ILED 100mA**



**ILED 350mA**



**ILED 500mA**



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